

ELECTROMAGNETIC FIELDS

Conference, Hearing
Call Up Cell Phone Use

Although experts agree more research is needed to investigate whether cell phone use can cause brain cancers, especially in children, a group of scientists, physicians, and public health specialists around the world are urging that simple precautionary measures be taken just in case. Environmental groups have also stepped up pressure for regulatory action, but very little has taken place in the United States to date. The widespread use of cell phones throughout the world makes questions about their safety “one of the most important matters that we have to deal with in public health today,” says Devra Davis, a professor of epidemiology at the University of Pittsburgh’s Graduate School of Public Health and co-organizer of a conference on the topic held in Washington, DC, in September 2009.

There were an estimated 277 million cell phone users in the United States as of June 2009, according to the industry group CTIA—The Wireless Association®, and about 4.1 billion worldwide, according to the United Nations. “With so many users, [cell phones] could translate into a significant public health problem should their use even slightly increase the risk of adverse health effects,” said John Bucher, associate director of the National Toxicology Program, at a hearing held during the conference by the Senate Labor, Health and Human Services, Education and Related Agencies Appropriations subcommittee.

Bucher also said the configuration of children’s skulls allows cell phone radiation—which falls between FM radio and microwaves on the electromagnetic spectrum—to penetrate deeper into the brain. In areas such as Africa and Brazil the majority of users are very young, Davis says. However, although some researchers believe children receive a higher

dose of radiation from cell phone use, no studies published to date have evaluated their risk.

In one of the most recent reports on the issue, a review of case-control studies comparing brain tumors in cell phone users versus non-users showed a slightly elevated risk of acoustic neuroma and glioma in people who began using cell phones as adolescents. Risk was highest for ipsilateral tumors—those occurring on the same side of the head that patients reported typically holding their phones—although such retrospective measures are notoriously difficult to confirm. The review was published in the August 2009 issue of *Pathophysiology* by Lennart Hardell and colleagues.

Hardell’s findings are supported by a meta-analysis published 13 October 2009 ahead of print in the *Journal of Clinical Oncology*, in which Seung-Kwon Myung and colleagues evaluated 23 epidemiologic studies and found that the 8 most rigorous studies showed an elevated risk of tumors in cell phone users compared with people who rarely or never used the phones. The risk was highest among those who had used cell phones for 10 years or more.

But assessments by the World Health Organization, the U.S. Food and Drug Administration (FDA), and technical organizations such as the Institute of Electrical and Electronics Engineers have concluded the available evidence does not demonstrate that wireless phones cause health effects, says Linda Erdreich, senior managing scientist at the consultancy Exponent, who testified at the Senate hearing at the request of CTIA. The FDA, one of two agencies that share regulatory authority over U.S. cell phones, states on its website that “The scientific evidence does not show a danger to any users of cell phones from [radiofrequency] exposure, including children and teenagers,” but nevertheless describes ways for cell phone users to reduce their potential exposure to radiation.

Dariusz Leszczynski, head of the radiobiology laboratory at Finland’s Radiation and Nuclear Safety Authority, stresses that the currently available scientific research about the effects of radiation emitted by cell phones is contradictory. He says, “In each area of investigation, there are studies showing effects and studies showing no effect [but] it is premature . . . to say that the use of mobile phones is safe.” Accordingly, the health agencies of Finland, France, Germany, Israel, Switzerland, and the United Kingdom have issued precautionary advisories regarding cell phone use for consumers of all ages.

When considered together, the research to date gives “a hint that something is going on,” particularly for people who have used cell phones for more than 10 years, but more

research is needed on more people to tell for sure, according to Siegal Sadetzki, head of cancer and radiation epidemiology at the Sackler School of Medicine’s Gertner Institute in Tel Aviv, Israel. She headed up a study published in the 15 February 2008 issue of the *American Journal of Epidemiology* that reported an elevated risk of ipsilateral parotid gland tumors among cell phone users who spent the most time on the phone.

Sadetzki’s work was part of the International Agency for Research on Cancer’s INTERPHONE study, which evaluated whether cell phone use can increase cancer risk. The study concluded in 2006, but although many of the individual components have reported results, a combined analysis still has not been published.

Given that the widespread use of cell phones did not begin until 1995, and based on observations of brain tumor growth in survivors of the Japanese atom bombings, any brain cancers linked to cell phone use wouldn’t be expected to become evident until at least 2032, Sadetzki says. The fact that any studies have found an association between cell phone use and such tumors is, she says, worrisome.

New research projects under way to help shed light on cell phones’ health risks include the Cohort Study of Mobile Phone Use and Health, which began earlier this year. This prospective cohort study will be conducted in Europe to assess cell phone use in relation to a variety of health effects, including brain tumors, blood cancers, and neurodegenerative and cerebrovascular diseases. The MOBI-KIDS case-control study, which will follow 1,900 people aged 10–24 years with brain tumors and a similar number without brain tumors for five years, is expected to begin recruiting next year.

To increase the amount of toxicologic data on the subject, the National Toxicology Program has begun a series of studies using special reverberation chambers to evaluate the effects on rodents of exposure to cell phone radiation. Rodents will be exposed for up to 20 hr a day to the same modulations and frequencies of cell phone radiation currently experienced in the United States. Results are expected in 2014.

“Until scientists have much more information about cell phone radiation, it’s smart for consumers to buy phones with the lowest emissions,” says Olga Naidenko, a senior scientist for the Environmental Working Group. She also recommends that people use a headset or speakerphone and substitute text messages for conversations when possible, and that children’s cell phone use be limited.

Kellyn S. Betts has written about environmental contaminants, hazards, and technology for solving environmental problems for publications including *EHP* and *Environmental Science & Technology* for more than a dozen years.



While public health experts debate the science of cell phone safety, parents debate how young is too young to have one of the devices.

DRINKING WATER QUALITY

Better Biomarker of DBP Exposure

When we drink chlorinated water or shower in it, we're exposed to chemicals called disinfection by-products (DBPs), which form when organic matter in water reacts with chlorine and other treatment chemicals. Some human epidemiologic studies have found associations between exposure to high levels of DBPs and increased risk of problems such as cancer and reproductive effects. But the DBP-disease connection is difficult for scientists to fully evaluate because methods for measuring exposure have been imprecise.

Most epidemiologic studies have used water supply levels of one class of these chemicals—trihalomethanes (THMs)—as a proxy for estimating exposure. Now two studies from Weiping Zhang and colleagues published in the September 2009 issues of the *Journal of Water and Health* and of *Biomarkers* provide new evidence that urinary and blood levels of another DBP, trichloroacetic acid (TCAA), make a reliable and valid biomarker for ingestion of this and possibly other nonvolatile DBPs.

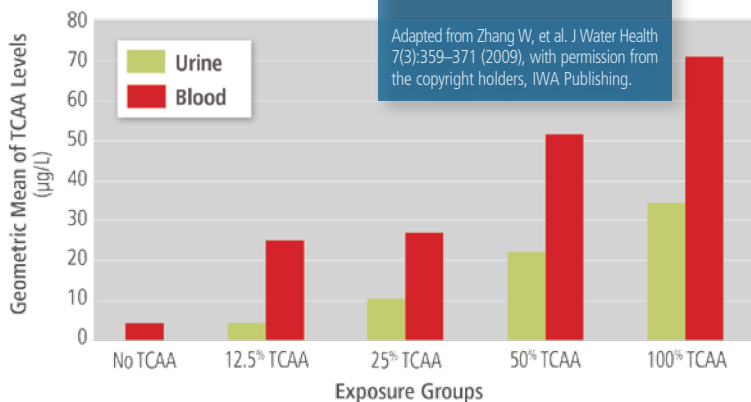
"THM levels in the water supply have been a convenient proxy for use in studies because many municipal governments already track these levels in the water supply. But indices of individual DBP exposure are needed," says Zhang, a scientist with Alberta Health and Wellness, a division of the Canadian provincial government. Scientists have identified biomarkers for measuring THMs in exhaled breath. But THMs persist in the body for only a very short time. TCAA, on the other hand, persists in the body for several days, offering a longer window for measuring exposure, Zhang says. However, she adds, knowing only water levels of any DBP does not address how much water anyone consumes.

In Zhang's tightly controlled study, for 15 days researchers delivered 3 L of cold tap water that contained a known amount of TCAA to each of the 46 participants. Participants were allowed to drink other beverages as desired, but when they drank water, they drank what the researchers provided. (For those who usually drank more than 3 L of water a day, the researchers provided extra

TCAA-free water.) Over the course of the study the researchers collected six urine samples and four blood samples from each participant. The participants recorded their daily consumption of water and other beverages, physical activity, showering/bathing time, and use of solvent-containing products. The

Study participants were randomly divided into 5 groups. One group served as controls and received TCAA-free bottled water. The other groups received TCAA-free water mixed with one of four concentrations (12.5%, 25%, 50%, or 100%) of city tap water containing a known concentration of TCAA.

Adapted from Zhang W, et al. *J Water Health* 7(3):359–371 (2009), with permission from the copyright holders, IWA Publishing.



researchers verified water consumption by retrieving the used bottles each day and recording the volume of fluid left.

The results showed that blood levels of TCAA made a better biomarker than urinary levels, but for large epidemiologic studies, measuring urine levels is more practical because the sample is collected less invasively, says Zhang, who often conducts field work. She concludes from her results that taking urine measures over two days and averaging them is preferable to a one-day sample, as the results showed better statistical reliability with repeated measures.

Other researchers agree that the findings represent a step forward. Susan Richardson, a research chemist with the U.S. Environmental Protection Agency, says the study has many strengths, among them a large group of participants that provided more statistical power than previous studies of TCAA, careful control of TCAA ingestion, and strong correlation between TCAA levels in the ingested drinking water and levels in the participants' urine and blood. Those elements add up to her opinion that TCAA is ready to be used as a biomarker of DBP exposure in epidemiologic studies.

Clifford Weisel, a professor of environmental and occupational health at UMDNJ–Robert Wood Johnson Medical School, suggests the TCAA biomarker

would be useful in a study when combined with some measure of other routes of DBP exposure, such as showering and bathing. "These studies show that TCAA will make a potentially good biomarker of ingestion of the haloacetic acids, in particular TCAA. But measuring TCAA won't address the issue of other exposures to DBPs such as those you get through inhalation or absorption through the skin," he says.

TCAA isn't a perfect biomarker. It's not yet known whether it can indicate ingestion of the most dangerous DBPs—other classes of compounds, such as iodinated and brominated compounds, which have been found to be much more toxic than chloroacetic acids. Further study

is needed to identify biomarkers for those more toxic compounds or to establish whether TCAA is a valid proxy marker for any of them, Richardson says. Weisel points out there may be sources of urinary TCAA other than drinking water; certain dry-cleaning solvents, for instance, are metabolized to TCAA once they enter the body. "It's hard to determine if that would interfere or not, because this population had very little exposure to those solvents," Weisel says.

Mark Nieuwenhuijsen, a research professor in environmental epidemiology at the Center for Research in Environmental Epidemiology in Barcelona, Spain, notes that choosing an exposure assessment method depends on study design. For instance, in a large population study, using THM levels in water may be preferable because collecting blood or urine samples may prove too expensive, he says. Access to subjects and timing also are important aspects to consider.

But overall, researchers call these findings a step in the right direction in an area that needs much more work. "These studies are very important because we have very few biomarkers for disinfection by-products," Nieuwenhuijsen says.

Angela Spivey writes from North Carolina about science, medicine, and higher education. She has written for EHP since 2001 and is a member of the National Association of Science Writers.

MATERIALS SCIENCE

Bringing Biolubricants to Industry

Up to 50% of lubricants used around the world are lost to the environment through evaporation, spills, leaks, and improper disposal, and contaminate soil and groundwater. "It's an underappreciated source of pollution," says Brajendra K. Sharma, a visiting research chemist at the U.S. Department of Agriculture (USDA) National Center for Agricultural Utilization Research in Peoria, Illinois. Now vegetable-based biolubricants offer an alternative to petroleum-based lubricants in a range of machinery, from elevators to ski lifts to chainsaws.

Vegetable oils have inherent disadvantages that limit their use in industrial applications, mainly destruction by oxygen, deterioration at high temperatures, and solidifying at low temperatures. Sharma and his colleagues designed a process to overcome these problems that requires a few simple steps such as adding an antioxidant. According to the researchers, the process generates no toxic products and uses existing equipment at facilities that manufacture petroleum-based lubricants.

"Simple chemistry and compatibility with existing operations are keys to getting industry to adopt our lubricants," says Sevim Erhan, formerly a chemist at the Peoria center and now director of the USDA Eastern Regional Research Center in Wyndmoor, Pennsylvania. She adds, "Our main goal is to make 100% biodegradable lubricants with nonpolluting processes to replace petroleum products." One antioxidant that has proven especially effective, zinc dialkylthiocarbamate, is "not considered hazardous," according to its Material Safety Data Sheet but nonetheless should be kept out of contact with soil, waterways, drains, and sewers.

Because performance requirements of lubricants differ for various industries, the team is exploring additional chemical modifications. In the September 2009 issue of the *Journal of Agricultural and Food Chemistry*, for instance, Sharma and colleagues described how they converted oleic acid to a stable form by adding formic acid and hydrogen peroxide, using aniline as a catalyst, and heating the mixture for several hours. This

"one pot" synthesis was easily performed and gave good yields, and the liquids used were recovered and recycled.

A few industries have adopted biolubricants. Since 2002, elevators in the Statue of Liberty have run on biodegradable hydraulic fluid. Hydraulic systems are prone to leaks, leaving puddles at the bottom of elevator shafts that run deep underground, raising the risk of groundwater contamination. "But soybean oil readily degrades, and there's little harm to the environment," says Jack Stover, president of Agri-Lube, Inc., in Defiance, Ohio, who licensed the USDA technology. The soybean-based hydraulic fluid shows excellent anti-friction and anti-wear properties and is less flammable than petroleum-based counterparts.

Penn State University in University Park switched all campus elevators and farm equipment to biodegradable hydraulic fluid. "About 35,000 gallons of oil in elevators has been replaced, and that's a significant amount," says Joseph Perez, a senior research scientist in the university's Department of Chemical Engineering.

Aluminum producer Alcoa, Inc., changed to biolubricants for its flat-rolling operations. During rolling, thick slabs of aluminum are flattened under heavy rollers into thin sheets that are shaped into vehicle panels, doors, beverage cans, and more. Lubricants are used in such operations to hold the aluminum and rollers together and dissipate heat. Ronald Reich, a technical consultant at Alcoa, collaborated with the USDA to create a biolubricant to replace petroleum-based lubricants that emit volatile organic compounds, which can cause eye and airway irritation, headaches, and other health problems. Because biolubricants are less volatile than petroleum-based lubricants, "we use less biolubricant to do the same job at a cost savings," says Reich.

Generally, biolubricants cost about twice as much as petroleum-based products, which hinders their adoption by more industries. "Biodegradable lubricants are a niche market right now," says Perez. However, a rise in crude oil prices could make biolubricants more cost-competitive. "Ultimately, it all boils down to cost," says Sharma.

Carol Potera, based in Montana, has written for EHP since 1996. She also writes for *Microbe*, *Genetic Engineering News*, and the *American Journal of Nursing*.

The Beat by Erin E. Dooley

Weather Comes the Flu?

Benjamin Giese et al. report in the September 2009 issue of the *Bulletin of the American Meteorological Society* that the 1918 El Niño not only was much stronger than previously believed but also may have exacerbated influenza mortality that same year. The flu link seems most plausible for India, a country hit especially hard by that year's Spanish flu pandemic, with 17 million deaths. The 1918 El Niño caused severe drought conditions in India, which contributed to a famine, weakening the population. The researchers note similar El Niño conditions are occurring this year.

Sister Study Success

When the NIEHS-sponsored Sister Study began recruiting participants in October 2004, its goal was 50,000 participants. Five years later the study has not only met but exceeded



Nearly 51,000 sisters have enrolled in the Sister Study

that goal, a rarity for studies of this size. The study participants come from all 50 states and across the demographic spectrum, all having in common the fact that they had a sister with breast cancer. The 10-year prospective study will examine environmental and genetic factors that may contribute to breast cancer risk.

EPA Advises on PCBs in Caulk

In September 2009, the U.S. EPA issued a set of best practices and testing guidelines for

building owners and school administrators to reduce exposure to PCBs found in caulk. PCB-laden caulk was used in buildings between 1950 and 1978, when the chemicals were phased out in the United States. The EPA also outlined research it will conduct over the next two years to help understand any health risks from PCBs in caulk; it is unclear whether or in what quantities PCBs in caulk migrate into air or dust. Findings from this research will guide the EPA in developing further recommendations to minimize exposures and safely remove the caulk. More information is available at <http://www.epa.gov/pcbincaulk/>.

Methylmercury Breakdown

In the 23 September 2009 issue of the *Journal of the American Chemical Society*, Jeremy Smith and colleagues reveal their discovery of the detailed mechanism of a specific enzyme found in bacteria, called MerB, that breaks down methylmercury. The team constructed a computational model of the enzyme's active site and used density functional theory calculations to

INVASIVE SPECIES

Pallet-able Change in Canada

Canadian border authorities are no longer accepting crates, pallets, and other solid wood packaging materials from China unless they are stamped with an internationally accepted mark confirming the material has been treated to remove invasive species that might be present in the wood. Cyndee Todgham Cherniak, a counsel in international trade law with Canadian legal firm Lang Michener, says, “[Invasive species in packaging materials] is not a new issue, but I think we’re taking the issue more seriously now than we have before, because pests are being met at the border, and border officers are seeing bugs they’ve never seen before.”

One such arrival is the emerald ash borer (*Agrilus planipennis*), an Asian native suspected to have originally hitched a ride into North America in wood packaging exported from that region. The Canadian Food Inspection Agency (CFIA)—which sets policy regarding the importation of food, plants, animals, and related products into Canada—says the emerald ash borer does not itself pose a direct threat to human health. However, the loss of trees led by the invasive insect represents a lost resource that naturally moderates urban temperatures and improves air quality by absorbing pollutants such as particulate matter, ozone, sulfur dioxide, and nitrogen dioxide. Since it was first detected in 2002 along the U.S.–Canada border flanked by the cities of Detroit and Windsor, the emerald ash borer has been officially identified in 13 U.S. Midwest states, in addition to Ontario and Quebec, wiping out tens of millions of trees along the way, according to the U.S. Department of Agriculture (USDA).

Prior to implementation of the new requirement in September 2009, solid wood packaging from China was allowed into Canada without standardized markings as long as it was accompanied by a “phytosanitary certificate” indicating the wood had been subjected to specific amounts of heating or fumigation with methyl bromide. These techniques became widely standardized in 2002 under the International Plant Protection Convention (IPPC), a treaty that includes nearly 200 member governments under the United Nations Food and Agriculture Organization.

A notice from the Canada Border Services Agency, which enforces CFIA policies at the border, states the CFIA changed the policy “due to

high rates of non-compliance from China.” Import agencies commenting on the issue state the difficulty more bluntly as “counterfeit certificates.”

But Julia Dunlop, a forestry specialist with the CFIA, points out that although the Chinese have the option of offering both types of certification, “they are officially suggesting that we recognize only the mark.” Dunlop adds that the move reveals how seriously China wants to be taken in terms of adhering to international standards for packaging among nations belonging to the IPPC.

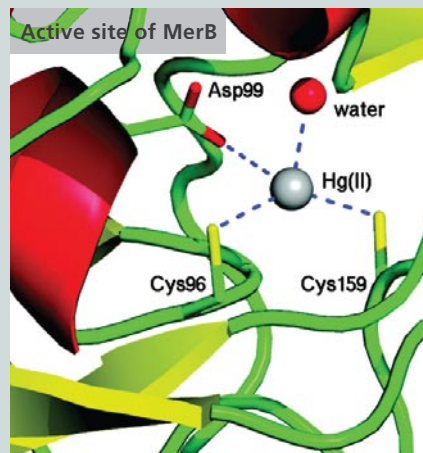
Those requirements set strict parameters for the mark so it can be readily assessed by border officials: it must at minimum include the IPPC symbol for treated wood packaging materials along with predetermined identification codes for the country of origin, the manufacturing facility, and the treatment applied. Marks must be legible, permanent, non-transferable, and visible on at least two opposite sides of the article being certified. Moreover, the colors red or orange are prohibited to avoid confusion with shipments of dangerous goods. The USDA Animal and Plant Health Inspection Service made the mark mandatory on U.S.-bound wood packaging in 2005.

While it is only logical for U.S. and Canadian authorities to begin demanding more stringent proof that such packaging has been purged of invasive insects, Todgham Cherniak insists it makes sense for the Chinese to appeal to a third-party organization like the IPPC for that proof. “We have to trust each other’s inspection agencies,” she says, arguing that participation in the IPPC opens up the operation of these national organizations to their counterparts in other member states. “You have to get to know the inspection agency, become comfortable, and do a thorough investigation to see whether it has up-to-date equipment and does a good job.”

In this way, she concludes, those same countries can be seen to offer environmental protection at home and abroad without incurring an economic penalty. “We’re protecting our people,” she says. “We are protecting our domestic market. But we’re going to facilitate trade. This is the best way possible: having mutual recognition.”

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simulate the demethylation reaction. They found the enzyme binds to methylmercury and rearranges electrons in the compound, priming it for breakdown. The researchers hope their findings will one day be applied to ecosystem-wide remediation efforts. In 2008, 27 states issued statewide advisories for mercury in freshwater bodies.



Getting Schooled on e-Waste

In September 2009 young scholars from around the globe gathered in Eindhoven, Netherlands, for the first NVMP-StEP E-waste Summer School organized by United Nations University. The event yielded recommendations for how to put millions of unwanted electronics from developed countries to further use in classrooms and small business in developing countries—and how to plan ahead to these machines’ disposal. Participants noted it is important to reuse electronics before they are too old or damaged to be reconditioned. Some participants advocate a return deposit for e-waste to keep it from collecting unused in closets and attics.

Cleanliness Is Next to Transparency

Two moves—one congressional, one industry-driven—are afoot to address the current lack of ingredient disclosure on household cleaning products. Trade secret protections mean only those ingredients that pose an immediate health threat are



currently required to appear on product labels, but Senate and House bills currently in committee would require products to carry complete ingredient lists. Meanwhile, the industry Consumer Product Ingredient Communication Initiative is developing a uniform voluntary system for informing consumers about product ingredients—with some key exemptions—that will launch in January 2010.